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Urban Transportation: The Canadian Experience

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Urban Transportation: The Canadian Experience

The Canadian transit industry has a leading edge in the development of new technologies. It is, therefore, appropriate that Transpo 86, a quadrennial exposition covering every aspect of modern transportation, will be held in Vancouver, British Columbia, for six months of 1986. Transpo 86 is expected to attract over ten million people from all over the world.

Many of these visitors will focus their attention on what Canada, the second largest country in the world, has learned about moving people and products over great expanses of difficult terrain. But the subject that promises to attract even greater interest is Canada's approach to urban transit, the world's newest transportation challenge.

Role of government

The successful achievements of public transportation in Canadian cities are chiefly the result of provincial and municipal policies. To meet public mobility needs, these governments have committed funds for transit research and development, the creation of new networks and the strengthening of existing systems.

Ontario has one of the country's most mature transit industries and a large number of cities with highly developed transit systems. By way of direct subsidies, Ontario funds 75 per cent of approved capital expenditures and 50 per cent of operating deficits. The province also funds the GO-Transit Commuter rail and bus service in metro Toronto and surrounding area.

Over the past seven years, Ontario has also spent large sums on research and development through its agency, the Urban Transportation Development Corporation Limited (UTDC), which was created in the early Seventies as an element of Ontario's new urban transit policy. Traffic congestion, air pollution and public resistance to freeways culminated in a broad provincial policy to improve existing roads and transit service.

The corporation has since produced a steady flow of new technology. Although not a manufacturer, UTDC has forged strong links with industry, government, transit operators, consultants and financial institutions. Its major programs have yielded new light rail vehicles, intermediate capacity transit systems and a range of advanced technology subsystems, including suspension and propulsion equipment. Technology developed and marketed by UTDC is manufactured under agreements by the private sector. The corporation's current research and development focus on advanced rail suspension systems, alternative energy technology, flywheel energy storage systems and an articulated (jointed) light rail vehicle.

Through its close association with other Canadian transportation authorities, UTDC also provides special advisory services. For example, the corporation worked with the United States' San Francisco Municipal Railway to improve vehicle maintenance and driver-training programs. The expertise of Toronto, Calgary and Montreal transit authorities was invaluable to the success of these programs. In Brazil, UTDC worked with transportation officials to help establish an organization in five state capitals to co-ordinate various public transportation services. This work was accomplished with assistance from specialists within the Toronto Area Transportation Operating Authority.

While no other province underwrites research and development costs to the same extent as Ontario, most offer direct subsidies to purchase capital equipment and to help offset operating deficits. Alberta, for example, will pay up to 100 per cent of the cost for approved new systems and up to 50 per cent of capital and operating deficit to a maximum of $3 *per capita.* It also assists with costs for transit studies.

In the field of electrically-powered vehicles, one of the country's first major new products was the Canadian Light Rail Vehicle (CLRV), developed by the Urban Transportation Development Corportation Limited. Initially designed as a replacement for 30-year-old streetcars, the CLRV is easily adpated for higher speeds in exclusive right-of-way operation. It can also be adapted (to be longer, wider, articulated, double-ended) to meet specific needs.

The Toronto version of the CLRV is a single-ended, four-axle vehicle powered by two rotary traction motors, each with blended, regenerative braking. It can operate singly or with as many as six units under the control of one driver. This vehicle was also designed for ease of maintenance, an important factor in reducing fleet size requirements and capital costs. The CLRV, which entered passenger service in Toronto in September 1979, is expected to have a 30-year life span.

UTDC also developed an advanced technology transit system to provide cities with economical transportation where passenger demand ranges from five to 25,000 passengers an hour. The program to develop this Intermediate Capacity Transit System (ICTS) began in late 1974 under a $60-million contract with the Ontario Ministry of Transportation and Communications. During the six-year program a prototype, including vehicles and all major components, was built and tested.

ICTS, a blend of conventional and advanced technology consists of compact trains powered by electricity, operating on exclusive rights-of-way. Capital costs are approximately $16 million *per* kilometre ($25 million *per* mile) compared with upwards of $60 million *per* kilometre ($100 million *per* mile) for subway. It is based on conventional steel-wheel technology and track-based switching, and thus is reliable in adverse weather, a critical factor since the system was designed to operate primarily on elevated guideways to avoid the high cost of tunnelling.

To reduce the noise and wear normally produced by steel-wheel trains, the development team devised a suspension system with steerable axles, permitting wheels to follow rails quietly through curves and avoid wheel-rail friction. ICTS also incorporates linear induction motors developed by Spar Aerospace Ltd. of Toronto, to meet the propulsion and braking requirements of the system.

Because ICTS operates primarily on elevated guideways, it is unobtrusive as well as quiet. The system, which uses 12.7-m (41.7-feet) vehicles, operates four-car trains on slender guideways. Stations are small in scale and may be integrated with existing structures. The fully automatic system permits trains to run 60 seconds apart.

By December 1979, the prototype construction and testing had been completed. In June 1980, ICTS underwent testing by the U.S. Urban Mass Transit Authority in order to qualify for application as a city centre transportation system.

The ICTS (or ALRT - for Advanced Light Rail Transit System) has been chosen for a rapid transit project in Vancouver, British Columbia. Vancouver, with a population of over one million, is Canada's major west coast port. The system is expected to be completed by 1986.

The Canadian Light Rail Vehicle (below and at right) *began service in Toronto in 1979 and is expected to have a 30-year life span.*

Canadian cities have been quick to recognize light rail transit's potential for service and cost-saving. In Edmonton and Calgary, fast-growing areas in Canada's oil-rich province of Alberta, rising oil prices boosted dramatically economic activity and populations during the past decade. To meet current and future public transportation requirements, both have embraced the idea of light rail transit to keep pace with urban growth.

Edmonton, the capital of Alberta, is the first city on the continent with a population of less than a million (500,000) to have light rail transit service. Construction of its 7.2-km (4.5-mile) line began in 1974 after a general transportation plan was adopted. The city's continuing growth rate has spurred an extension to this original line, and a study is under way to examine extension.

Calgary is a growing city with a great deal of new commercial development downtown. Like Edmonton, it abandoned streetcars in the early Fifties in favour of trolley coaches and buses. Bus systems, however, failed to keep pace with the transportation needs created by the booming oil economy and expanding population. Auto congestion in the city centre and the spectre of increasing demands for more auto-related facilities increased the need for a less expensive urban transit alternative.

Light rail transit was the answer and in 1977 detailed design and construction of the first line began. The $145-million system, which opened in spring 1981, runs 12.6 km (7.89 miles) serving residential, retail and industrial areas of the city. Specific characteristics of the corridor made it necessary to construct only 1.3 km (.81 miles) of the line underground.

New bus technology is also attracting the attention of several Canadian cities which are investigating the potential of articulated buses. With their higher passenger-to-driver ratio, these buses can greatly reduce operating costs and total fleet requirement. Fewer vehicles also mean lower capital and maintenance costs. The Ottawa-Carleton Regional Transit Commission will test 22 of these larger buses in Ottawa starting next year, while Edmonton expects to take delivery of 25 in 1983-84.

Edmonton is the first city on the North American continent with a population under 500,000 to have light rail transit service.

Marine link

Ground transportation technology is not the only area in which Canadian cities are taking a lead. In 1974, the Department of Municipal Affairs in British Columbia took the first step toward solving a persistent transit problem in Vancouver by seeking proposals from several naval architectural firms to design a marine link between North Vancouver and the city proper across the 3.2-km (2-mile) Burrard Inlet.

The result was a unique 400-passenger seabus which provides service across the inlet in 12 minutes with free transfers to or from regular city buses. This ferry can accommodate 1,600 passengers an hour. Seabus was developed by Case Existological Laboratories Ltd. To ensure high stability at terminals during loading and unloading, as well as manoeuverability in each direction, the vessels have a double-ended catamaran design with four combined propulsion and steering units, one at each end of both hulls. (Double-ending reduces the need for turning at terminals, increases trip speed and safety, and permits continuous loading and unloading.) The all-aluminium construction saves 15 per cent in fuel consumption and requires considerably less maintenance than steel.

The Burrard Inlet Ferry, commonly known as ''Seabus'', prepares to dock in North Vancouver after a 12-minute harbour crossing.

A centre for technology development

One of Canada's most important facilities for the development of new urban transit technology is the Transit Development Centre (TDC), located near Kingston, Ontario. Established and operated by the Urban Transportation Development Corporation, the centre is a comprehensive facility where the transit community, both in Canada and abroad, can develop new technology. It is equipped with a 2.5-km (1.43-mile) electrified standard-gauge test track, test vehicles, laboratories, maintenance and training facilities, automatic train-control equipment, and telemetry and data evaluation systems, with its own engineering and administration offices. Additional facilities will be added as they are required.

This 194-hectare (480-acre) centre, the heart of UTDC transit technology development programs, has become the focal point of a substantial amount of all transit development work in Canada. With a staff of more than 150, the TDC is an important resource for the North American transit industry. Research and development have been conducted at the centre for Transport Canada, the Ontario Ministry of Transportation and Communications, Britain's London Transport and the U.S. Department of Transportation.

The Urban Transportation Development Corporation's research and development centre near Kingston, Ontario boasts a 2.5-km test track.

A tradition of transportation innovation

The Transit Development Centre of the UTDC (photos above) *covers 194 hectares (480 acres) and has a staff of over 150.*

For a country with only two cities of three million and only one of a million, Canada has developed a surprisingly broad range of transit know-how.

Canadian transportation expertise has its roots in the early nineteenth century, when the nation's first railroad was hauling passengers and freight in 1832. By 1886, the country was linked east to west by rail. Today, two transcontinental railroads stretch from coast to coast, while smaller regional railroads augment these two systems to form an integrated network more than 7,000 km (4,350 miles) long.

Canadian airways, roadways and waterways are also highly developed. Two major carriers, Air Canada and Canadian Pacific, fly passengers and freight to both domestic and overseas destinations; remote areas of the country are linked to larger centres by regional carriers. The complex of roads and highways maintained by federal, provincial and local governments serves 12 million motor vehicles in the country, as well as many more driven by visitors. Extensive waterways reach into the heart of the land.

Urban transit development

The computerized control tower of the Transit Development Centre at Kingston overlooks an electrified test track.

Following the Second World War, Canada's economy, fed by an influx of foreign investment and a renewed demand for peace-time goods, shifted into high gear. Migrants from rural areas joined immigrants from Europe in the race for jobs and a better living standard in the manufacturing centres, touching off the most explosive period of urban growth in Canadian history. The "baby boom" of the late Forties and Fifties swelled urban populations impressively. Many cities doubled or tripled their population over the following 25 years. Today, some 75 per cent of Canada's 24 million people live in cities.

This rapid urban growth led to a variety of transportation problems, many of which are familiar in both industrialized and industrializing nations. Housing pressures within cities, for instance, sparked development of endless tracts of low-density residential sprawl on the outskirts. Because urban sprawl is expensive and difficult to service with high-quality public transportation, Canadians bought more automobiles to take them from their suburban homes to their jobs in the city. A high-growth economy and plentiful, low-cost oil made this commuting possible.

As a result, Canadian cities faced all the problems associated with large-scale auto use. Traffic congestion increased on access roads and in central business districts. Air and noise pollution diminished the quality of life downtown, while valuable urban space was wasted on new roadways and parking facilities. Capital expenditures for auto-related infrastructure and services increased dramatically.

Freeways were built on a limited scale to improve access to city areas. Canadian municipalities, however, have traditionally regarded freeways with some suspicion, recognizing that they destroy both the integrity and quality of life of neighbourhoods through which they pass. Canadians also benefited from the experience of the U.S. cities, where it was demonstrated that

freeway construction encourages further suburban development with resultant increases in automobile use.

Despite the dominance of the automobile during the years of rapid urban growth, Canada's largest cities maintained and expanded their public transportation systems to provide an alternative means of travelling within their boundaries. In small and medium-sized cities such as Ottawa and Vancouver, the alternative is a highly reliable bus system. Larger centres such as Toronto and Montreal constructed integrated, multi-modal transit systems which provide passengers with inexpensive, dependable and comfortable transportation. These systems were planned, built and commissioned by the municipalities, and most of the equipment required for them was designed, developed and manufactured in Canada.

The number of customers for public transit is increasing steadily as service improves and oil prices climb. In the past decade, transit ridership in Canada has risen by about 250 million to more than 1.22 billion passengers in 1978.

Publicly-owned systems

In Montreal, public transportation began in 1861 with a horse-drawn railway operated and owned by a private firm. By 1895, three private companies provided service in the city and surrounding areas. These were merged into one company in 1911. By 1950, the facilities needed to be expanded and overhauled. Public ownership was the answer.

Public ownership came earlier in Toronto. In 1920, the Ontario Legislature passed an act permitting municipal ownership of public transportation within the 90 km^2 (35 square miles) of the city. By 1923, nine separate systems had been unified to co-ordinate public transit. Today the municipally-owned Toronto Transit Commission provides all urban transit services in the metropolitan area. It is funded by the municipality, with capital and operating subsidy assistance from the province.

Improving urban life with transit

Public transportation's efficient use of land and its economic benefits are easily illustrated by the experience of metropolitan Toronto. The Toronto Transit Commission operates a sophisticated and integrated network of subways, streetcars, trolley buses and diesel buses throughout the 632 km^2 (244 square miles) of the metropolitan area. Investment in transit, particularly in the subway system, has ensured the development and continued commercial success of the city's core. Access to the centre of the city plus efficient methods of traffic circulation have made the downtown area attractive for high-density office complexes, retail outlets and apartment buildings. New development has spread outward from the centre of the city, following the route of the subway system.

Today, Toronto is recognized throughout North America as a model in the area of public transportation with its dynamic and economically successful downtown area. Fifty per cent of passenger trips into the core during rush hours are made by this method.

Most national governments today are increasingly concerned with the cost and supply of imported oil. Since urban transportation by private automobile accounts for a significant proportion of the oil consumed by many nations, there is growing interest in reducing auto use. Public transportation addresses the energy problem directly. In peak travel times, urban diesel buses are approximately 11 times more efficient than automobiles, achieving approximately 100 passenger-kilometres *per* litre of fuel compared with approximately nine passenger-kilometres *per* litre with standard automobiles. The fuel efficiency of electrical mass transit systems is similar to that of buses on a passenger-kilometre-*per*-litre basis.

Transit also answers concerns about exhaust emissions. Major emissions from internal combustion engines include hydrocarbons, carbon monoxide, oxides of nitrogen and sulphur and particulates. In round numbers, automobiles produce eight times as much emission pollution as buses or diesel commuter trains on a passenger–kilometre basis. Electric transit vehicle pollution is limited to emissions produced in generating electricity at the source. Pollution takes a heavy economic toll in urban areas because of its adverse effects on health (health costs as well as time lost from work) and on buildings and equipment.

A major benefit of efficient urban transportation facilities is realized in capital investment. Stated simply, transit is less capital-intensive than the automobile. Studies conducted in the cities of Vancouver and Halifax in the 1970s indicated that the cost of providing transit facilities to meet travel demands through the 1980s was roughly half the cost of providing facilities for automobiles. Transit means fewer expressways and access roads; less parking space; savings on traffic-signalling equipment; and savings on police, fire-fighting and ambulance services.

Solely in terms of the amount of land required for transportation, a recent study found that public transit in Toronto—bus and rail—requires from five to eight hectares (12-20 acres) *per* 100,000 passengers a day, compared to 280 hectares (700 acres) for automobiles.

Toronto facilities

Metropolitan Toronto, on the north shore of Lake Ontario, is a major hub in the commercial and industrial machinery of Canada. Its successful transportation system grew out of its determination to provide a viable alternative to the automobile in the downtown area. Today, its three million inhabitants have easy access to almost all parts of the city by way of a highly integrated network of subway, streetcar and bus lines. This extensive system has contributed to the fast-moving commercial character of Toronto's core. It is also one of the chief reasons why so many people choose to live in the city centre.

The Toronto Transit Commission is responsible for providing service throughout the city of Toronto and the five boroughs comprising the metro area. The TTC is responsible for planning, building, operating and maintaining transit facilities under the direction of five commissioners appointed by the Metropolitan Toronto Council.

Prior to 1954, the TTC provided services primarily in the city of Toronto, an area of approximately 90 km^2 (35 square miles). Its jurisdiction grew to 635 km^2 (245 square miles) almost overnight with the introduction of metropolitan (or regional) government. The reorganization of municipal government, however, had been planned so that integration of various services such as policing, fire-fighting and urban transit would be achieved smoothly and with a minimum of disruption.

Toronto's three million inhabitants can reach the city centre by a highly integrated network of subway, commuter train, streetcar and bus lines.

Buses and streetcars are often given exclusive right-of-way on downtown thoroughfares.

Cars, which otherwise would be clogging and polluting downtown streets, are seen at Toronto's Islington station.

Below: *A subway line is extended by tunnelling instead of by the more expensive ''cut and cover'' method.*

Rapid growth and high levels of immigration in the Toronto area occurred during the next 15 years. Massive land tracts were carved from outlying boroughs for suburban housing, creating an urgent need for the expansion of public transportation facilities. In 1963, the TTC launched an ambitious program to put bus service into the sprawling suburbs surrounding the city. By 1974, public transit was available within 600 metres (2,000 feet) of 95 per cent of all metro residents.

This rapid expansion of service between 1954 and 1974 required the purchase of four suburban bus lines and some 2,000 passenger vehicles, including 30 used streetcars, 28 used trolley buses, 40 new trolley buses, 1,355 diesel buses and 504 rapid transit cars.

It was during this period too that Toronto acknowledged the need for rapid transit. The central business district was becoming increasingly congested with automobiles and surface transit networks. Toronto planned and constructed the first leg of its modern subway system (the first built in North America after the Second World War) to provide service in the most heavily travelled area downtown. Since that time, the subway system has been extended in stages to today's 53-km (34-mile) network.

Toronto has 53 kilometres (34 miles) of subway lines which carry 720,000 passengers every day.

Original art graces the subway platforms at the Spadina (top) *and Eglinton West* (bottom) *stations in Toronto.*

Montreal Métro

Montreal's modern subway also originated from concerns about the deterioration of the downtown area. Immediately before construction of the Métro, street congestion in the city centre had reached alarming proportions, despite previous improvements to surface transportation. Intensive construction of high-density developments planned or under way at the time threatened to swamp the core with massive traffic congestion. Narrow streets, unusual topography and harsh winters made it impossible to make the surface system more effective.

In 1961, the city council approved funding for a 16-km (10-mile) subway. Construction began after a year of intensive planning. In 1963, the original plan was extended to cover 26 km (16 miles), with 26 stations. In less than five years, at a cost of $213.7 million, the first passengers were riding on the world's newest subway.

Since that time, the Métro has been further extended and improved. Many large-scale downtown developments, such as Place Bonaventure and Alexis Nihon Plaza, were built with direct access to the subway. The city constructed a network of underground pedestrian passages, with links to the Métro and city core department stores. Many of these passages—built with public, private and joint-venture funds—are lined with retail stores that provide thousands of city residents and visitors with year-round shopping in a controlled environment. This underground world accommodates 250,000 people and links railway stations, hotels, cinemas, theatres and office buildings, promoting the commercial success of the core.

Although originally designed to alleviate traffic congestion and to increase public mobility, the Métro has greatly contributed to the revitalization and growth of Montreal's central city by providing rapid transit which can support additional development. It gives direct access to the city centre from outlying areas and helps people circulate in the core. Closely spaced stations, especially in town, ensure passengers a short walk to the nearest stop.

The 38-km (24-mile) long Montreal Métro is noted for the unique architecture of its 45 stations.

Bottom: *Montreal Metro's rubber tires permit a smooth, quiet ride, reducing the noise and vibration transmitted to surrounding buildings.*

The planned approach

By and large, the days of random city growth have passed. Modern cities attempt to avoid future problems by projecting trends, examining their anticipated effects, and devising a course of action which will create the type of community desired.

The intensive planning which precedes installation of public transportation services in Canadian cities is evident. In Hamilton, Ontario, for example, major corridors have been identified where rapid transit will reinforce the municipal policy of retaining the city core as a focal point for new development. One of these corridors is being considered for demonstration of the new Automated Light Rapid Transit System (ALRT) developed in Canada. Prior to installation, however, the regional municipality is conducting a one-year preliminary program to examine the environmental impact of the system on surrounding areas, its exact alignment within the corridor, soil conditions and final system design. In addition, users are being invited to express their views. Once this is concluded, the municipality will decide whether to proceed with the ALRT.

In Vancouver, British Columbia, the ALRT has been chosen for regional and city service. The first step was to identify an appropriate alignment on the basis of current and expected travel patterns, land-use policies and planned developments within the city. The result was a 23-km (14-mile) rapid transit route connecting New Westminster and downtown Vancouver.

In Edmonton and Calgary, new light rail transit systems are being built to serve the downtown area and to meet land-use goals.

Consulting and technical expertise

In addition to the urban and transportation planning expertise which has evolved over the years, Canada also possesses a pool of experienced consulting and technical personnel. Canadian specialists, in both the public and private sectors, build, operate and maintain subways, light rail transit services, commuter rail and bus networks and urban bus services. This experience is available to municipalities anywhere in the world on a commercial basis.

The computerized control centre of the Toronto Transit Commission can quickly identify delays or other problems in the system.

Montreal's Metropolitan Transit Bureau, for example, now provides a range of services for installing integrated public transportation systems. Drawing on the skilled personnel responsible for building and operating the city's own network of subways and buses, the Bureau provides the expertise needed to construct, equip, test and service rapid transit systems for both domestic and foreign municipalities.

The Urban Transportation Development Corporation Limited of Ontario also offers a wide range of advisory and technical services to the international market place. Staffs of major Canadian transit operators, private-sector consultants, planners and industrial specialists provide a variety of services in areas such as vehicle maintenance, driver training and transit-operations management.

Regional co-ordination

The Toronto Area Transportation Operating Authority (TATOA), an agency of the Ontario government, was created in the early Seventies to operate commuter services and to co-ordinate municipally operated transit systems. Its jurisdiction includes the Municipality of Metropolitan Toronto plus five regional municipalities in the area.

TATOA's major responsibility is to administer GO-Transit, a regional commuter system of trains and buses which serves an area containing more than 3.6 million people, a figure that is expected to climb to 6.5 million by the end of the century. The system operates on three major routes. The rail fleet consists of 25 locomotives, nine auxiliary power control units, 123 single-level coaches and 80 new two-level coaches. Trains are operated by the Canadian National Railway (CNR) under contract. Approximately 400 CNR employees plus 300 GO-Transit personnel are required to run the system. The bus fleet, operated by private carrier under contract, consists of 160 vehicles, all of which are owned and maintained by the agency.

The hub of the commuter-rail system is Toronto's Union Station, where all three lines converge. Union Station is also the southern terminus of the Toronto subway line, giving GO passengers direct access to the city's extensive subway, streetcar and bus transportation. Similarly, many GO stations along the three routes are integrated with regional urban transit services and provide free parking and "kiss and ride" (limited stop) automobile facilities. GO is also conducting experimental fare-integration programs whereby passengers ride both local bus and GO rail by paying a single fare.

GO-Transit's objective, to reduce the number of automobiles on the road has been largely reached because it operates a convenient, reliable service for a fair price. It also helps meet regional transportation objectives set by the municipalities and the province.

GO-Transit is a commuter system of 225 trains and 160 buses serving some 3.5 million people in the Toronto region.

The construction of subway lines has spawned considerable commercial and residential growth around new stations.

Toronto is the only Canadian city not to have abandoned its streetcars, some of which date from the early 1950s.

Many suburban subway and commuter train stations have "kiss and ride" car bays.

Buses, trolleys and light rail vehicles

Montreal, Toronto and Victoria introduced electric streetcars in the early 1890s. by the early 1920s, the era of electric street-rail service was in full bloom in most major Canadian cities, providing reliable transportation in the city centre and to surrounding regions by way of extensive radial lines. During this period a number of advances were made, including the introduction of double-track vehicles for improved passenger comfort, single operator "pay-as-you-enter" cars to reduce operating costs, and steel cars to replace wooden vehicles.

All Canadian cities except Toronto abandoned their original streetcar systems in the early 1950s in favour of diesel bus lines. Toronto has stayed in the forefront of modern light rail technology with the introduction in 1979 of the Canadian Light Rail Vehicle. The TTC initially ordered 196 of these smooth, quiet streetcars for immediate service.

During the 1920s, Canadian cities began introducing buses to serve low-density areas where the capital expenditure for fixed rail was unwarranted. This new form of transit would eventually replace electric rail in all cities except Toronto, for it offered flexibility and lower capital costs. In Toronto, these early bus lines were used to feed the streetcar system. Today, larger cities such as Montreal and Toronto use buses both for primary service and to feed rapid transit lines.

As bus transit became more popular, advances were made in passenger comfort and reliability. With the introduction of diesel-powered buses, fuel economy was added to the benefits. Canada now boasts a strong bus-manufacturing industry centred primarily in the provinces of Quebec, Ontario and Manitoba.

Ottawa's bus service

Many medium-sized cities continue to rely on buses as their single mode of urban transit. Ottawa, the national capital, with a population of half a million, is served by the Ottawa-Carleton Regional Transit Commission (OC Transpo), said to be North America's most highly patronized bus system. More than 70 per cent of all people entering the downtown area in the morning rush hour do so by bus. OC Transpo provides 150 trips *per capita* every year. Only cities with rapid transit enjoy higher rates.

OC Transpo is popular because it is willing to experiment and provide a variety of services to meet special needs. For example, Ottawa was one of the first cities in Canada to implement a successful "dial-a-bus" service using special small buses to pick up passengers at their homes and take them to a centre for transfer onto a fixed-route bus—all for a 25-cent surcharge on the regular fare.

Ottawa passengers also appreciate OC Transpo's efforts to move them downtown more quickly *via* limited stop and express buses. During rush hours, the 63 regular routes are supplemented by 21 limited-stop and 23 express routes, also at a 25-cent surcharge. OC Transpo offers "early-bird" service from 4 a.m. to 6:30 a.m., transportation for the physically disabled in specially equipped buses, and service to sporting and recreational events. Riders may purchase a pass for unlimited trips—monthly passes for adults and students or yearly passes for senior citizens. In 1982, OC Transpo is taking delivery of 22 articulated buses as part of an extended test of this technology.

OC Transpo serves an area of 285 km² (110 square miles) with 744 buses and approximately 1,750 em-

Several Canadian cities will soon begin trial runs of Canadian-built articulated buses.

ployees. In 1971, the system carried 35.5 million passengers. By 1980 ridership had escalated to 74.6 million.

Like buses, electric trolley buses were first introduced in Canadian cities in the early 1920s. Although they were quiet, non-polluting and comfortable, trolley buses passed from favour during the Fifties and Sixties in most cities. Interest in this equipment picked up again in the Seventies—the Toronto Transit Commission for example, rebuilt 152 old trolleys rather than replace them with diesel buses. Edmonton and Vancouver are acquiring 100 and 150 trolley buses respectively.

Focus on rapid transit

In recent years, Canada's biggest cities have concentrated on modern rapid transit to move large volumes of riders quickly. While planning, constructing and operating two major subway systems, Canadians have acquired a broad range of rapid transit experience which spans the steel-wheel/steel-rail system in Toronto and the rubber-tire technology of Montreal.

The Métro's rubber tire cars not only provide passengers with a smooth, quiet, comfortable ride, they also transmit minimal noise and vibration to surrounding buildings and civil structures; this eliminates the need for sound-proofing in tunnels and stations. In the completely closed environment of the Métro, rubber-tire suspension also permits safe, reliable acceleration and braking on grades up to 6.5 per cent.

Vehicles are just 17 m (56 ft.) long and 2.5 m (8 ft. 3 in.) wide. Because trains are closely spaced and make frequent stops, the cars are equipped with four double doors each side to allow rapid passenger exchange. Stopping time at staions is approximately ten seconds.

Métro trains comprise three-car elements each

Computerized communications can put subway control centres into instant touch with cars in the system.

consisting of one unpowered car between two powered units. Trains use from one to three elements, depending on passenger demand. Station platforms run 152.4 m (500 ft.), the length of a complete nine-car (three-element) train. The Métro operates entirely in two-way underground tunnels, 70 per cent of which were pushed through solid rock. Montreal was one of the first cities to lay its subway runways rigidly and directly on a perfectly levelled floor of the tunnel. Remaining tunnel was built by the "cut-and-cover" method.

Montreal's subway, which is 38 km (24 miles) long, is noted for its reliable and safe service, the unique architectural features of its 45 stations and its quiet, comfortable operation. Today, Métro carries approximately half a million passengers on an average weekday. It is fully integrated with the 2,000-vehicle bus system, offering passengers free transfers between the two modes.

In Toronto, construction of the first leg of the city's subway began in late 1949. The Younge Street subway line originally ran 7.2 km (4.5 miles). Today, Toronto has 53 km (34 miles) of subway lines which carry 720,000 passengers daily.

Unlike the Montreal Métro, Toronto's subway is based on steel-wheel technology, which permits the system to operate reliably during winter months in open sections. Except for the first 140 cars, which were purchased abroad, all TTC rolling stock has been manufactured in Canada. The TTC led the way in specifying long, lightweight cars for its subway system; this has produced savings in capital, operating and maintenance costs. Toronto's most modern cars are equipped with air conditioning, cantilevered seats and a redesigned suspension system for improved ride.

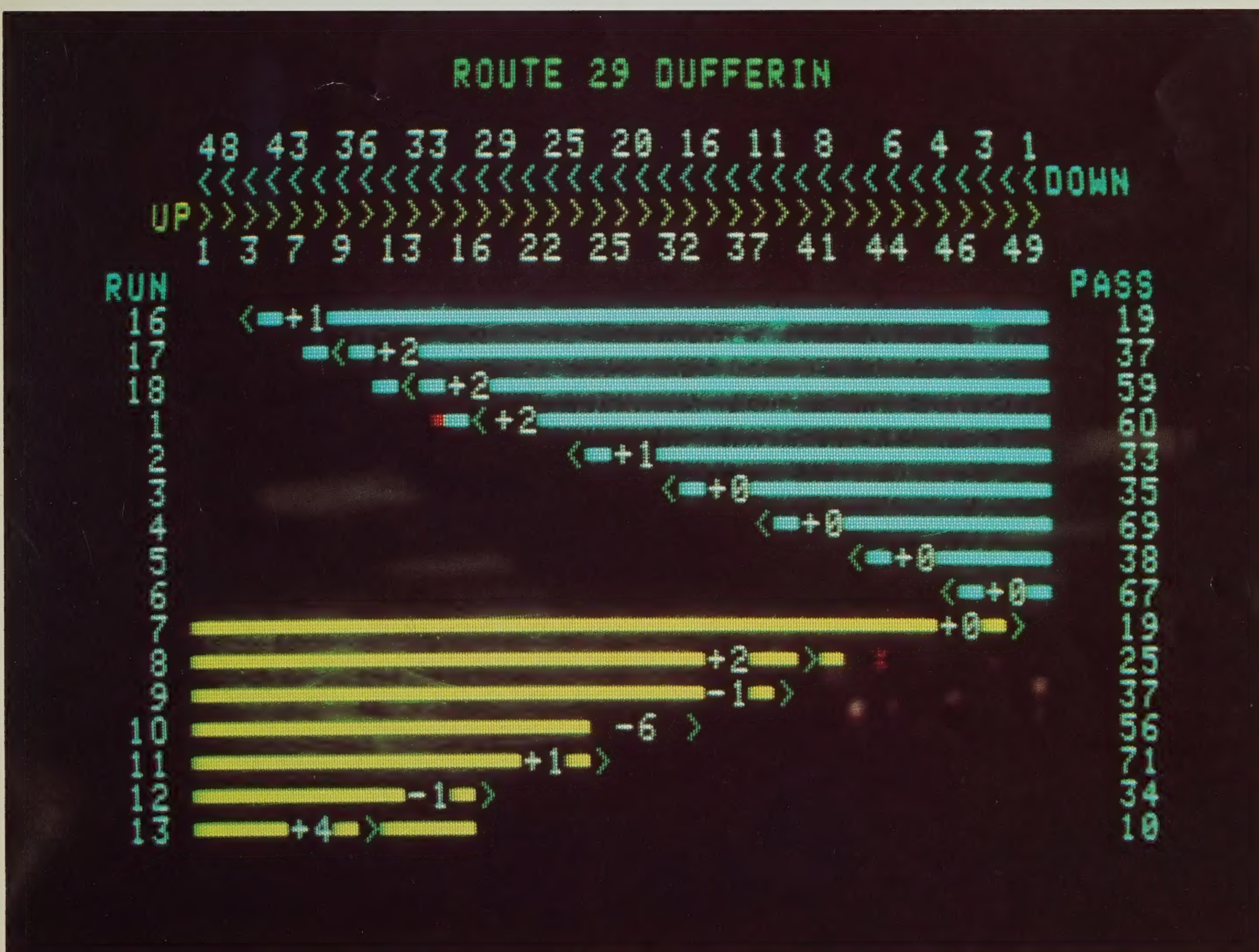
New technology on conventional equipment

Today, conventional bus systems in cities are being improved through new communications and information equipment— from simple two-way radios linking bus operators and a central controller to complex on-board micro-processors and data collection devices. The Toronto Transit Commission, for example, has installed a system with computer-based data and radio links between 100 vehicles and a central control point. It can locate any bus in the network at any time, determine the number of passengers and if the vehicle is on schedule.

Buses in a number of cities—including Ottawa, Montreal, Edmonton and Halifax— are also being outfitted with information systems. To prevent long waits at bus stops in the city of Mississauga, Ontario, an automatic information system enables passengers to dial a telephone number which includes codes for any particular route and stop. A computer voice then informs the passenger of the arrival time of the next two buses. A similar system is being used on a limited basis in Ottawa.

New equipment has been developed for commuter rail services as well. For example, GO-Transit's rail service had become so popular with Toronto area commuters by the mid-Seventies that the operating agency was forced to alleviate overcrowding. As a result, GO began replacing its single-level coaches on the busiest routes with new two-level cars, which are unique in North America and carry 70 per cent more seated passengers (162 seats). They are equipped with air conditioning, a public address system, high-backed seats, carpeted floors, a washroom and a drinking fountain. GO-Transit now operates a fleet of 80 award-winning bi-level cars designed and manufactured by Hawker Siddeley Canada Limited of Thunder Bay, Ontario.

New technology also has been added gradually to the country's two subway systems over the years. In Toronto, a computerized train dispatch and information system was installed in 1979 to replace existing electro-mechanical dispatchers. The system permits rapid response to subway train delays and service changes. In addition, Toronto's sleek new subway cars



Modern computers can locate all units on a transit route and tell whether they are on schedule.

incorporate "chopper" control devices for smoother, more energy-efficient acceleration and braking.

The Montreal Métro replaced its conventional signalling system with continuous speed control and programmed stops at stations. In addition, chopper control and regenerative braking technology (whereby power is returned to the electrical supply during deceleration) are now standard equipment on new rolling stock.

Conclusion

Over the past 80 years, Canada has developed a solid foundation of transit specialists. The urban transportation systems they have built offer affordable and reliable service to millions of people daily. The broad base of research and development personnel and the evident public support ensure a continuing evolution of the technology and equipment.

The Canadian transit-manufacturing industry meets both domestic needs and the requirements of the highly competitive international marketplace. The export of millions of dollars in new equipment every year illustrates that Canada's transit manufacturing sector is well able to compete in tough international bidding.

GO-Transit's two-level cars, unique in North America, carry 70 per cent more seated passengers (162) than the single-level cars.

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